

Conduit Coating Abrasion Testing

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1. Abstract

During my summer internship at NASA I have been working alongside the team members of the RESTORE project. Engineers working on the RESTORE project are creating a device that can go into space and service satellites that no longer work due to gas shortage or other technical difficulties. In order to complete the task of refueling the satellite a hose needs to be used and covered with a material that can withstand effects of space. The conduit coating abrasion test will help the researchers figure out what type of thermal coating to use on the hose that will be refueling the satellites. The objective of the project is to determine whether or not the conduit coating will withstand the effects of space. For the RESTORE project I will help with various aspects of the testing that needed to be done in order to determine which type of conduit should be used for refueling the satellite. During my time on the project I will be assisting with wiring a relay board that connected to the test set up by soldering, configuring wires and testing for continuity. Prior to the testing I will work on creating the testing site and help write the procedure for the test. The testing will take place over a span of two weeks and lead to an informative conclusion. Working alongside various RESTORE team members I will assist with the project's documentation and records. All in all, throughout my internship at NASA I hope to learn a number of valuable skills and be a part of a hard working team of engineers.

2. Background

Hydrazine is a chemical used as propellant for rockets in space. Hydrazine is a liquid chemical at temperatures between 35°F and 100°F; it is vital that the hydrazine stays between these ranges of temperatures. If the temperatures exceed above or below this range, then the hydrazine will eventually ignite or may freeze solid causing damage to the space craft's

structure. To prevent the hydrazine temperature from increasing, a coating must be used to reflect energy away from the surface of the propellant line. Z93C55 coating is a heat absorption coating that is very delicate and once it is coated onto the desired object, it should not be touched. If the coating is touched, it has the potential to flake off or become damaged. Emissivity is the measure of how much energy can be absorbed into the material or how much energy will reflect off the surface. The Z93C55 coating has a high emissivity which allows the coating to insulate the conduit and will protect the Hydrazine from becoming unstable due to increased temperatures.

3. Test Design and Set Up

My role in the RESTORE project involved helping with the conduit Z93C55 Thermal Coating abrasion testing efforts that have been underway at the Kennedy Space Center (KSC) for the past several months. The purpose of these testing efforts is to evaluate how a conduit coated with Z93C55 would interface with a roller mechanism that is to be used to attach the conduit to its target.

The conduit testing took place in the EDO Lab at KSC over a two week time period. Prior to my arrival at KSC, a testing mechanism had been designed and built specifically for this particular test. During testing, the conduit was placed on a PVC pipe so it could roll back and forth, thereby simulating the “roller movement” that the conduit would experience in space. The “grip force” and

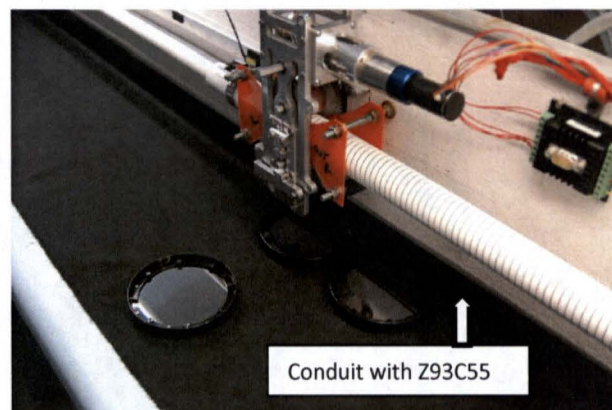


Figure 1. Conduit Coating Set Up. While working with the RESTORE team I helped with the setup of the test mechanism and the testing area.

“compression” tests were created to determine how the roller movement would impact the conduit’s surficial Z93C55 thermal coating. The tests were conducted such that, initially, the conduit was ‘rolled’ back and forth ‘x’ number of times, then increasing to ‘y’ number of times and so on to determine whether or not the conduit’s coating was impacted. To test the abrasion of the Z93C55 Thermal Coating three petri dishes were placed around the rollers in order to collect the debris that fell from the conduit. This was later taken to a laboratory to be analyzed. While being analyzed at the laboratory, researchers will determine how much material separated from the conduit and how it would affect the performance of the conduit. Initial testing results indicate that the rolling effect should not negatively impact the surface of the tested conduits and this is a promising result; otherwise, if the conduit surface had failed by deteriorating and flaking off, then the conduit would not be properly coated and may not be able to withstand the impact of space.

4. Wiring Efforts

The Conduit Coating Test involved the conduit moving back and forth between the two rollers; to make this process easier and more efficient an electrical system was created. This electrical system involved two magnets that, when hit, would reverse the movement of the conduit and keep track of the number of cycles the conduit had been through. This helped the researchers know exactly how much of the conduit had been affected by the rollers and how many times each section of the conduit had been under the force of the rollers. I was able to offer some hands-on assistance with the conduit coating abrasion testing efforts by soldering various wiring systems and helping with various electrical tasks. I helped solder resistors on a number of wires to help withstand the electricity that would be flowing through the wires. I also helped solder, connect and configure the wires in the electrical box and its associated power system. I

assisted with connecting the wires to the plugs by stripping the wires and crimping them to their plugs; this would allow the power supply to connect to the electrical box. Additionally, I conducted continuity tests to check the wires in the electrical box to make sure there was enough electricity running through the wires from its source. These test were very important and helped make the overall conduit coating test run smoother and more efficiently. While working with RESTORE I gained a lot of knowledge about electrical engineering and I learned how to use a number of engineering tools.

5. Data Collection and Organization

Another way that I was able to offer hands on assistance to the RESTORE project was through data collection and organization. I took time to meet with the project's engineers to determine how I should proceed with the data collection. Based upon their input I created several Excel tables that would help organized and keep easily accessible the information that was being recorded during the testing, I was present throughout the testing and was able to accurately record and document the data that was being collected during the testing procedures.

I also helped write the test's set up and procedure documentation. I was able to perform this task because I was present during the assembly and construction of the testing equipment and mechanisms. While writing the procedures I found it much easier to accurately state what needed to be done because I had witnessed and helped with the construction of the testing equipment. Along the way I did have to make a few changes to the test set up and procedures that I had already written because the engineers renumbered the measurement system on the roller mechanism's setup. This experience taught me that a testing scenario is a fluid and

dynamic situation in that it can change based upon the changing situations and the needs of the project.

6. Lessons Learned and Experience Gained

I have learned many things through this internship with NASA. I was introduced to the field of electrical engineering through my work with the RESTORE project and had the chance to do some hands-on electrical work such as wire stripping, soldering and wire continuity testing. I also improved my Microsoft Word and Excel computer software skills while writing the test set up and procedures and while collecting and organizing the testing data.

The testing went well overall and the RESTORE team learned a lot about the Z93C555 coating. Overall the coating withstood the force from the rollers and performed well during the compression testing. The test truly benefitted the RESTORE project and will help the development of a satellite servicing spacecraft in the near future.

Working on the RESTORE project, I had the chance to be part of a 'team' who worked together each day toward a common goal. Also, throughout my internship experience I attended numerous project team meetings and over time I gained the confidence to speak up about my ideas regarding the project. I also learned that engineering projects, however well-planned and thought out, can change based upon "real-time" situations and scenarios. All in all, my summer internship at NASA has been an experience of a lifetime; I have learned a variety of useful skills ranging from hands on engineering work to learning how to work well with a large team. This internship truly has been an informative and beneficial experience that will help in my future as an engineer.